

The global impact of glaucoma*

B. Thylefors¹ & A.-D. Négrel²

Although glaucoma is a major global cause of blindness, the lack of a uniform definition of the disease in its different forms makes it difficult to assess its public health impact. By considering the common features of glaucoma, we have analysed available data on the three main forms of the disease: congenital/hereditary glaucoma, primary open-angle, and primary angle-closure glaucoma. A simple model was then developed to estimate the extent of glaucoma on a regional basis, taking into account demographic data, e.g., age distribution, gender and ethnic groups. Overall, the results demonstrate that glaucoma is responsible for approximately 5.2 million blind (15% of the total burden of world blindness).

Although glaucoma is a major cause of visual impairment and blindness all over the world, there is only limited information available on the exact magnitude of the problem posed by the disease. When WHO was planning its programme for the prevention of blindness, glaucoma was included in the need for action against global causes of avoidable blindness (1)—the others being cataract, trachoma, vitamin A deficiency, and onchocerciasis. WHO was specifically requested by the World Health Assembly in May 1975 “to introduce adequate measures for the early detection and treatment of other potentially blinding conditions such as cataract and glaucoma” (1).

It has, however, proved very difficult to obtain sufficiently uniform and epidemiologically valid data on glaucoma in its various forms and on the amount of visual loss caused. There has, therefore, been little progress in preventing blindness from glaucoma in developing countries; furthermore, the complexity of

the disease with regard to early detection and treatment still poses problems.

Case definition

A major difficulty with glaucoma and the blindness that it can lead to is the lack of a uniform case definition. Glaucoma commonly refers not to a single disease, but to a group of disorders that have certain common features, in particular:

- cupping and atrophy of the optic nerve head;
- characteristic visual field loss; and
- often, but not invariably, increased intraocular pressure.

Of these cardinal signs, visual field loss is diagnostically the most specific, since both cupping and intraocular pressure exhibit physiological variations in a given population. However, visual field loss is a late manifestation of glaucoma, and therefore is not particularly suitable for the early detection of the disease; also, it is not easily investigated reliably in large-scale population screening in developing countries. Both assessment of the cupping of the optic disc and increased intraocular pressure (IOP) have been used as early indicators of glaucoma in a number of screening campaigns in developed countries. The absence of specific cut-off levels that accurately predict glaucoma has made such campaigns expensive and required extensive follow-up of a large number of borderline cases or glaucoma suspects. Epidemiologically, unless there is a defined

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¹ Programme Manager, Programme for the Prevention of Blindness, World Health Organization, 1211 Geneva 27, Switzerland. Requests for reprints should be sent to this author.

² Ophthalmologist, Programme for the Prevention of Blindness, World Health Organization, Geneva, Switzerland.

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sample or catchment area, with a known denominator and attendance, the data from glaucoma screening campaigns should be interpreted with caution.

Available data

Using the information available in the WHO Global Data Bank on Blindness, we have analysed selected glaucoma survey data, chosen on the basis of their epidemiological relevance. Even if only the proportion of blindness caused by glaucoma identified in these surveys is taken into consideration, the results are far from clear. The range of the proportion of blindness due to glaucoma was 6.7–21.0% in six countries with blindness registers (Chile, Denmark, Germany, Iceland, United Kingdom, and USA) and 3–22% in 26 surveys from 19 countries (17 countries in Africa and Asia, plus Peru and Turkey) (2). The results of the review suggest, however, that around 10% of global blindness is attributable to glaucoma.

At the request of the World Bank, WHO started in 1992 to make global disease estimates for the commonest conditions. The results have appeared in the *World development report 1993* (3), which focuses on the global burden of disease and the implications in terms of disability.

The WHO Programme for the Prevention of Blindness has, therefore, developed a simple disease model for glaucoma in order to make reasonable estimates of the extent of the disease in various parts of the world and its impact in terms of visual loss. This activity is an ongoing process, and the data presented here will be revised as more accurate information becomes available from population-based assessments in a number of countries.

For the purposes of this model, we classified glaucoma as follows:

- congenital (genetic or developmental);
- primary (open angle or angle closure); and
- secondary.

The definitions applied in the literature search and for available data were:

- high IOP, i.e., >21 mmHg;
- congenital glaucoma, when diagnosed at birth or during childhood, as a primary glaucoma or in conjunction with congenital anomalies;
- primary open-angle glaucoma (POAG) in the presence of characteristic optic disc cupping (cup/disc ratio >0.5) and/or visual field changes; the presence of high IOP was not considered essential, since up to one-third of cases may be “low-tension glaucomas”, which were therefore included as POAG in the model;

- primary angle-closure glaucoma (PACG), when there was evidence of an occludable angle: history of symptoms; disc cupping (cup/disc ratio >0.5); visual field defect(s); history of specific surgery; and a positive provocative test;
- secondary glaucoma, when evidence of the triad of signs was associated with known ocular or systemic disease; since such cases are often unilateral, and blindness is usually caused by the primary disorder, the number of blind resulting from secondary glaucoma was not determined.

The model was developed, based on the populations in nine different regions as defined by the World Bank. In each region, the demographic profile was considered, i.e., the distribution by age and gender; the prevalence of POAG among Black populations was taken to be four times that among Caucasians (4, 5). It was noted that most published studies have reported significantly higher ocular tension in females than males, but there is conflicting evidence as to the attributable risk of gender in relation to POAG. Women are, however, generally at increased risk of PACG (male:female = 1:3); there is also a higher prevalence of this form of glaucoma among Asian populations than Caucasians (6).

In the model each defined region was considered in terms of its demography, and existing data on glaucoma were used to estimate the age-specific prevalence rates for males and females, and for each type of glaucoma (see Fig. 1). There are no reliable data on the incidence of glaucoma, hence the rates were calculated on the basis of age-specific prevalences.

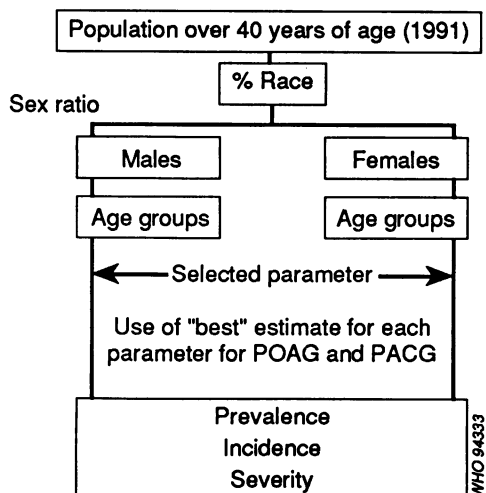
Disease and disability projections

The model has obvious weaknesses, but it is useful for performing global disease estimates. As the availability of epidemiologically valid data increases, the accuracy of these estimates will rapidly improve. In the meantime, the following conclusions can be drawn with regard to prevalences:

- the total number of glaucoma suspects in the world (IOP >21 mmHg) is around 105 million persons;
- congenital glaucoma affects 300 000 children, representing a very small part (1.3%) of the global glaucoma problem;
- globally, POAG affects about 13.5 million people over the age of 40 years — this constitutes 60% of the total global burden of the disease;
- PACG, which has a similar age distribution to that of the open-angle form, accounts for 6 million cases (26.6% of the total global burden of glaucoma);

Fig. 1. Schematic representation of the regional models for the assessment of primary open-angle glaucoma (POAG) and primary angle-closure glaucoma (PACG).

- Nine regions (according to World Bank definition)
- For each region



- the remaining 12.1% of glaucoma is accounted for by 2.7 million cases of secondary glaucomas caused by other ocular or systemic disease.

The geographical distribution of POAG by the nine defined regions (Table 1) shows that more than 50% of cases are found in China, because of its demographic weight with 28% of the world's over-40-year-olds; Africa south of the Sahara, with its Black populations; and in the established market economies, where the proportion of over-40-year-olds is particularly high (42% compared with 17% in Africa). Overall, approximately 70% of the world's cases of POAG are found in developing countries.

Turning to PACG (Table 2), it is striking that almost two-thirds of all cases are found in China and in Asian and Pacific countries. This reflects the known higher prevalence of angle closure in Asian populations, as well as their relative demographic weight. More than 80% of all cases of PACG live in developing countries.

Assessment of blindness due to glaucoma is complex, since it is related to access to detection and treatment, stage of disease when diagnosed, life expectancy and, in some cases, compliance with treatment. It is thus necessary to consider a "case-disability" rate in glaucoma; this is presumably very high in remote rural areas of developing countries, where the likelihood of ever receiving appropriate

Table 1: Distribution of primary open-angle glaucoma (POAG), by World Bank region

	% of global total of POAG
Established market economies	17.6
Former socialist economies of Europe	7.2
Latin America and the Caribbean	6.7
Sub-Saharan Africa	19.4
Middle East/North Africa/South-west Asia	5.2
China	20.1
India	12.9
Other Asian and Pacific countries (high income)	3.6
Other Asian and Pacific countries (low income)	7.2

treatment is very low. On the other hand, recent data indicate a case-disability rate of 5% for glaucomatous blindness in Denmark (7). In the overall global model, the case-disability rate is 23%, which is a reflection of the above-mentioned circumstances in developing countries. The following glaucomatous blindness estimates were obtained:

- congenital glaucoma: 200 000 blind;
- POAG: 3 million blind; and
- PACG: 2 million blind.

This corresponds to a global total of 5.2 million blind due to glaucoma.

If available data on blindness from 1984 are updated to the 1990 global population, it can be assumed that there are currently 35 million blind in the world (8), applying the international definition of blindness as the inability to count fingers at a distance of 3 metres (or 10 feet) (9). The above estimate of 5.2 million individuals who are blind due to glaucoma indicates that this condition is responsible for 15% of global blindness. This implies that glaucoma is the third most important global cause of blindness, after cataract and trachoma (Table 3).

Table 2: Distribution of primary angle-closure glaucoma (PACG), by World Bank region

	% of global total of PACG
Established market economies	5.6
Former socialist economies of Europe	2.3
Latin America and the Caribbean	1.6
Sub-Saharan Africa	0.6
Middle East/North Africa/South-west Asia	1.3
China	37.1
India	12.7
Other Asian and Pacific countries (high income)	8.8
Other Asian and Pacific countries (low income)	17.6

Table 3: Estimates for the major global causes of blindness in 1990^a

	No. of blind ×10 ⁶
Cataract	16.0 (46) ^b
Trachoma	5.6 (16)
Glaucoma	5.2 (15)
Others	8.2 (23)
Total	35 (100)

^a Estimates for 1984 adjusted to reflect the 1990 global population.

^b Figures in parentheses are % of the total global blindness.

Despite the shortcomings of the simple model we have described, it illustrates the importance of glaucoma as a global cause of visual loss. Unfortunately, not much has been undertaken so far in terms of prevention of blindness from glaucoma in developing countries; this is not surprising in view of the constraints of difficult early detection and follow-up of cases, often with a need for specialist care. The management of glaucoma should be seen as an emerging priority that so far could not be tackled effectively in developing countries, because of the scarcity of trained personnel and the lack of resources for eye care. In the future, however, it may be possible to provide new and efficient strategies for the prevention of visual loss and cost-effective treatment within the structures and means available in those countries most at need.

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